MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

EMG2016 – ELECTROMAGNETIC THEORY

(All Section / Groups)

11 OCTOBER 2016
9:00 A.M- 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 8 pages with 4 Questions only.
2. Attempt **ALL FOUR** questions. Each question carry equal marks and the distribution of the marks for each question are given.
3. Please write all your answers in the Answer Booklet provided.
4. If Smith Chart is used, please submit the used one(s) together with the answer script.

Question 1

(a) A distortionless line operating at 120 MHz has the following parameters:

$R = 20\ \Omega/m$, $L = 0.3\ \mu H/m$, $C = 63\ pF/m$

Calculate:

(i) The propagation constant.

[3 marks]

(ii) The phase velocity.

[3 marks]

(iii) Characteristic impedance.

[3 marks]

(iv) How far will a voltage wave travel before it is reduced to 20% of its initial magnitude?

[4 marks]

(b) An 80 Ω transmission line is operating frequency of 12 MHz is terminated by a load. At 22 m from the load, the input impedance is 100-j120 Ω. Assuming $u = 0.8c$, Find:

(i) The reflection coefficient.

[3 marks]

(ii) The voltage standing wave ratio.

[3 marks]

(iii) The load impedance.

[3 marks]

(iv) The input imepdance at 28 m from the load.

[3 marks]

Question 2

(a) Write the four mathematical expressions, in differential form, that contribute to Maxwell's equations.

[6 marks]

(b) From one of the Maxwell equations in (a) and by using Stokes's Theorem, derive the equation for Faraday's law in the integral form.

[7 marks]

Continued...

(c) A closed loop in triangular shape as Shown in **Figure Q2** is made of conducting material. The magnetic field passing through the loop is given by $\vec{B} = B_0 xy^2 e^{at}\ \hat{z}$ Wbm^{-2}, where B_0 and a are constants.

(i) Determine the flux that passes through the loop.

[7 marks]

(ii) Determine the voltage at the voltmeter.

[5 marks]

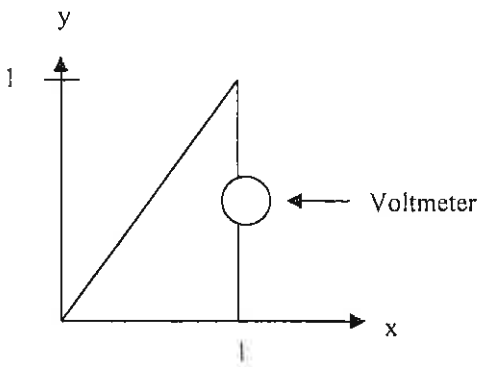

Figure Q2

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Question 3

A sinusoidal electric wave with amplitude 25 is polarized in $\hat{y}$ and travelling in a lossless medium in negative x direction. Given $\varepsilon_r = 9$ $\mu_r = 4$, and the frequency of the wave is 10 GHz. Find the following:

(i) β and η

[4 marks]

(ii) The expression of $\vec{E}$ in time domain

[3 marks]

(iii) The expression of $\vec{E}$ in phasor form

[1 mark]

(iv) The expression of $\vec{H}$ in time domain

[3 marks]

(v) The expression of $\vec{H}$ in phasor form

[1 marks]

(vi) The Poynting vector, $\vec{S}$

[3 marks]

(vii) The Power Density, S_{av}

[2 marks]

(viii) If this wave hit normally into another lossless and nonmagnetic medium with $\varepsilon_r = 4$, find $\overrightarrow{E^r}$ and $\overrightarrow{E^t}$ in time domain.

[8 marks]

Continued...

Question 4

a) A rectangular waveguide with cut-off frequency of 3 GHz is to operate at 15GHz. Given that the waveguide is filled with a medium with relative permittivity $\varepsilon_r = 4$ and relative permeability $\mu_o = 1$, calculate for TE_{10} mode,

i) The phase constant

[3 marks]

ii) The phase velocity

[3 marks]

iii) The wave impedance

[3 marks]

b) What is meant by the term 'dominant mode' in a waveguide?

[2 marks]

c) An air filled copper waveguide has dimensions of a=2.286cm, and b=1.016cm. Find the cut-off frequencies of the first four propagating modes. Determine the dominant mode.

[10 marks]

d) Given a hollow square waveguide with TE_{10} cut-off frequency of 10GHz. Determine the dimensions of the waveguide.

[4 marks]

Note: For a rectangular waveguide, the cut-off frequency is given by,

$$f_{c,mn} = \frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

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Appendix A

Physical Constants and Units

Constant	Symbol	Value (mks units)
Speed of light in vacuum	c	3×10^{8} m/s
Electron charge	q	1.602×10^{-19} C
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Permittivity of free space	ε_0	8.8542×10^{-12} F/m
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ N/A^2
Electron volt	eV	1 eV = 1.602×10^{-19} J
Planck's constant	h	6.626×10^{-34} J·s
Electron rest mass	m	9.11×10^{-31} kg
Effective electron mass	m_e	$0.068m$
Effective hole mass	m_h	$0.56m$

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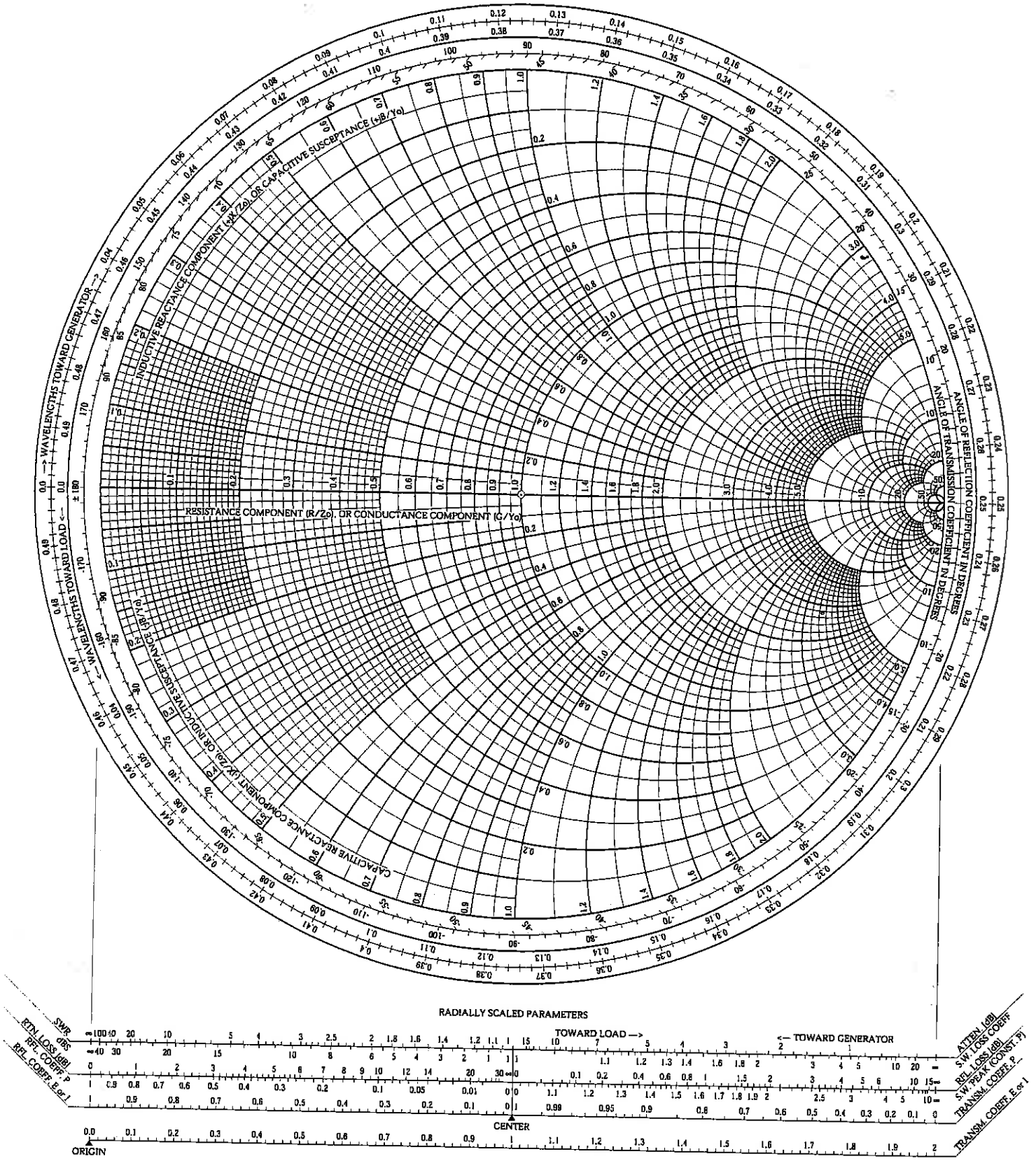
The Complete Smith Chart

Black Magic Design



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The Complete Smith Chart

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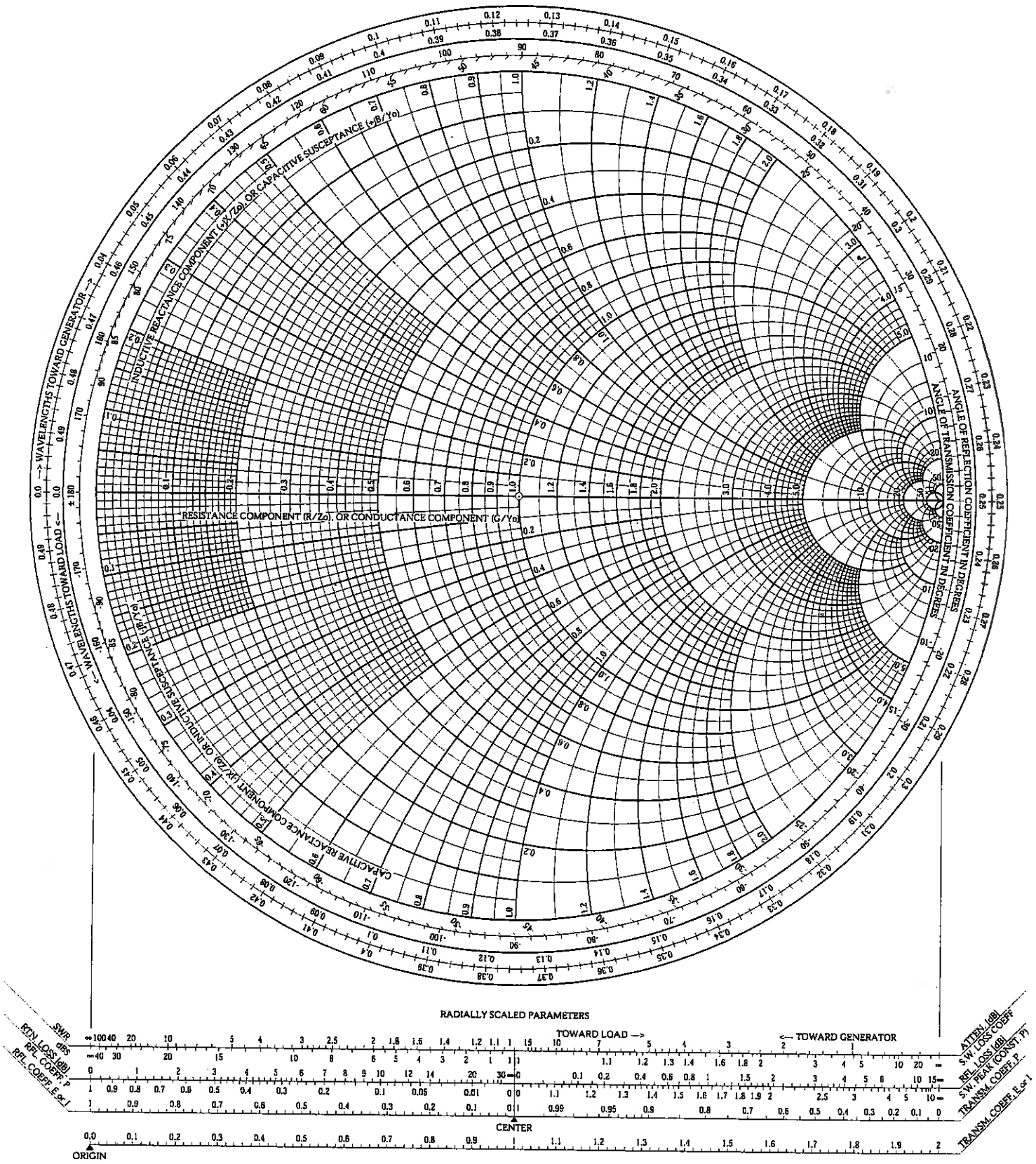

End of paper.